Transatlantic Collaboration of Citizen Astronomers in Follow-Up Exoplanet Detection: A Joint Observation of TOI 2031.01

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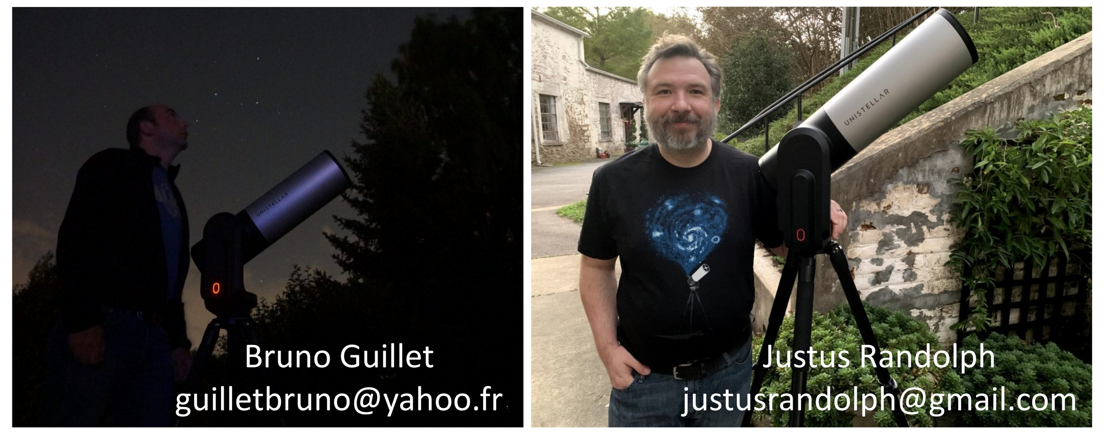
Citizen Astronomers and their eVscopes



Introduction

Here, we demonstrate the feasibility of citizen astronomers coordinating efforts to detect exoplanet transits with an example of a joint, two-telescope, ***transatlantic*** observation. This type of coordination mitigates constraints set by visibility from a single site, thus making more transits observable from the ground.

The Story

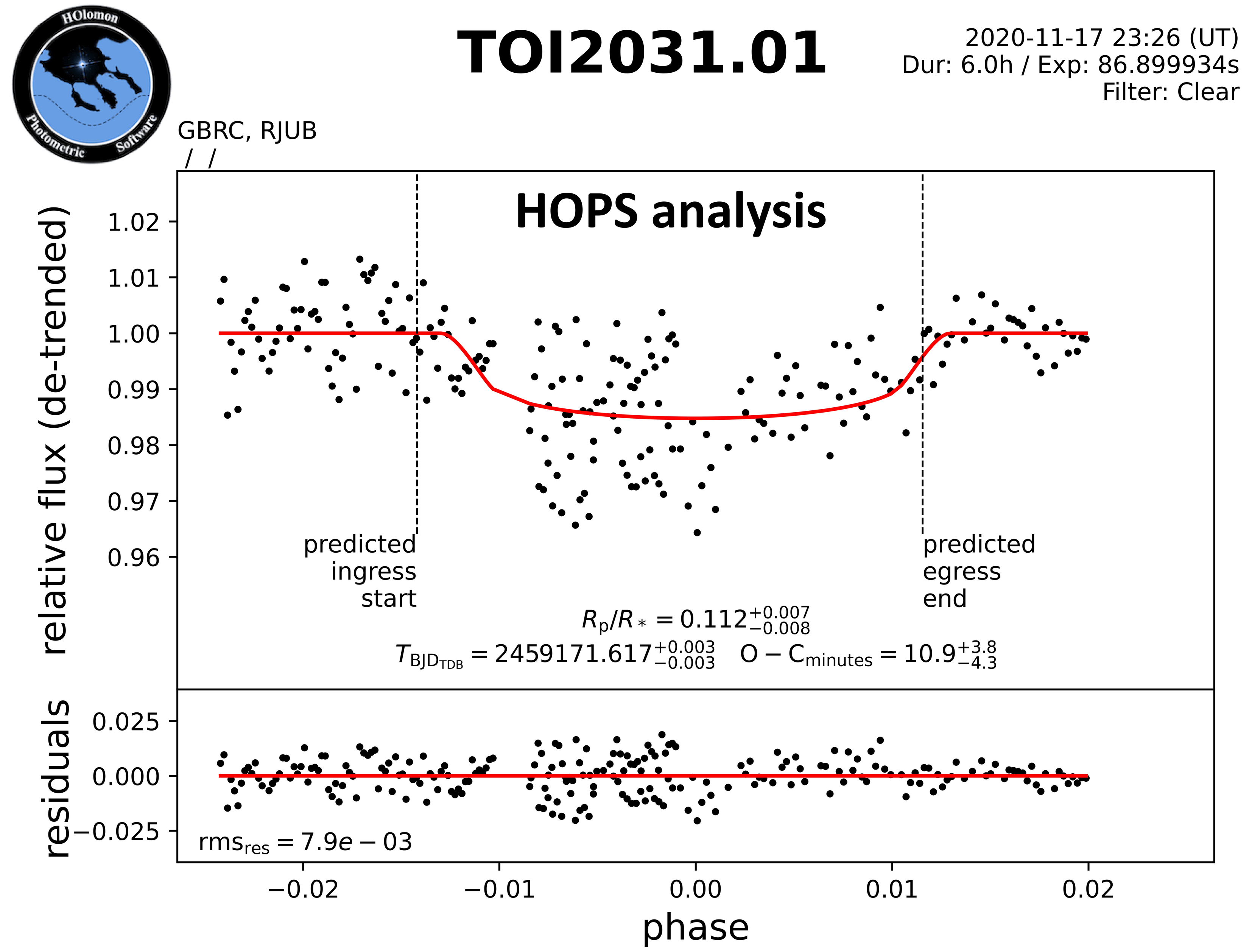
Two citizen astronomers—one in France and one in the United States—connected through the Unistellar Network. They used the Swarthmore Transit Database to identify a target and plan the observation. Each citizen astronomer observed complementary parts of a transit by the hot Jupiter TOI 2031.01 on November 18, 2020, using identical Unistellar eVscopes.

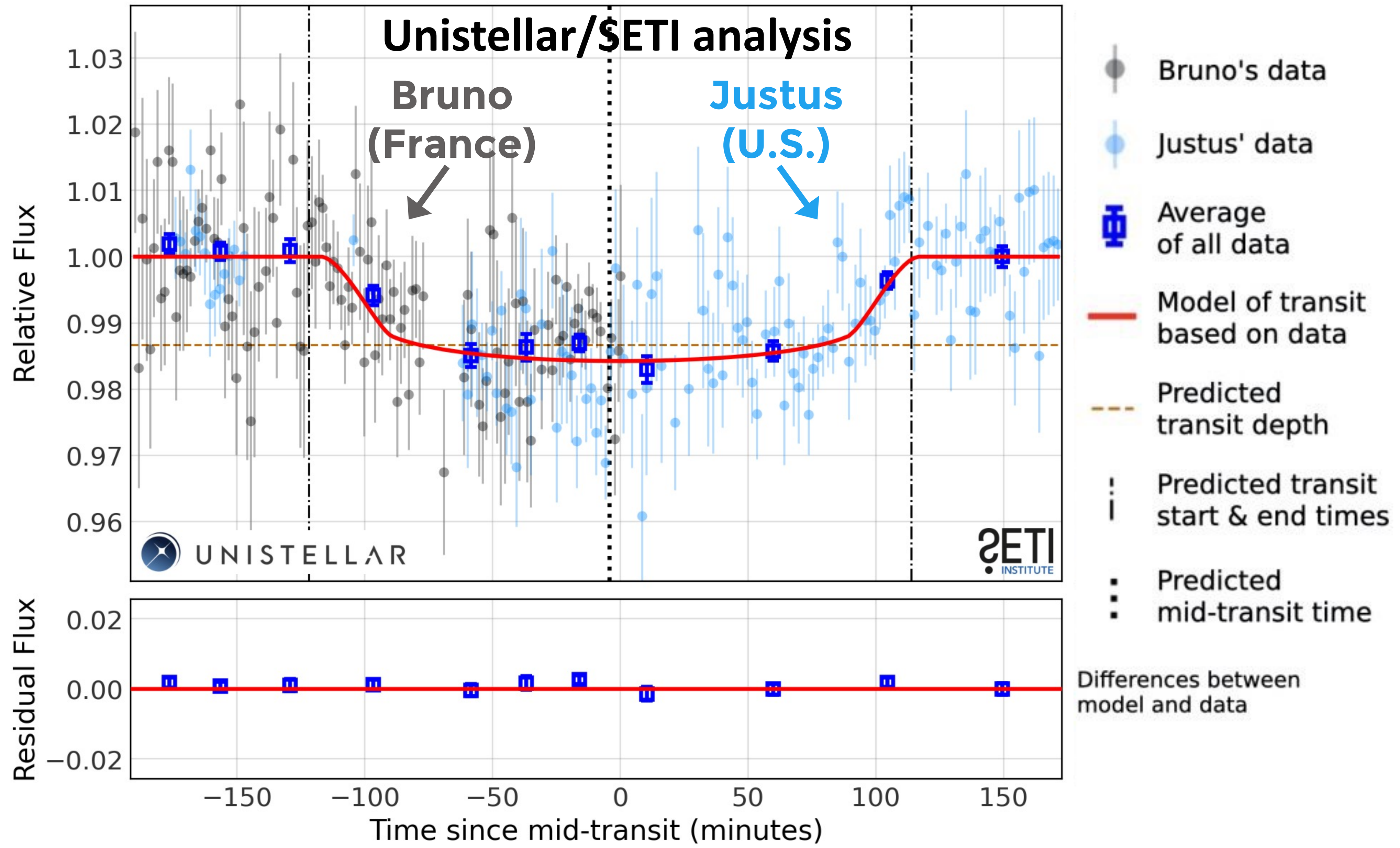
Host Star

TOI 2031.01
22:04:28 +81:33:57 (J2000)
V magnitude: 11.25
Spectral type: ~F4V

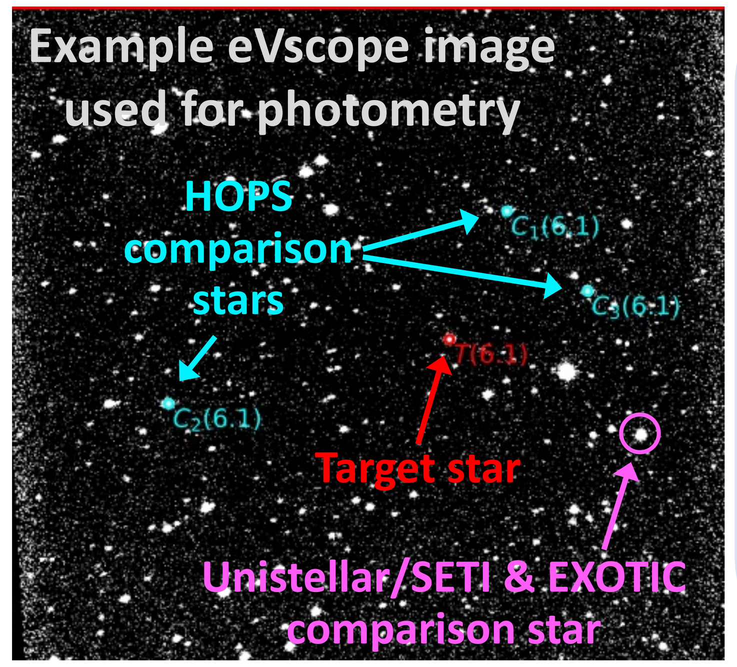
Planet

Period: 5.71547 ± 0.00001 d
Radius: 1.23 ± 0.05 $R_{Jupiter}$





Analysis source	Mid-transit time (BJD_TDB - 2450000) ➔ Time from prediction	Transit duration (minutes)	Planet radius to Star radius ratio
HOPS	9171.617 ± 0.003 ➔ +10.9 $^{+3.8}_{-4.3}$ minutes	Not output	0.112 $^{+0.007}_{-0.008}$
EXOTIC	9171.614 ± 0.002 ➔ +6.2 ± 2.9 minutes	220 ± 140	0.114 ± 0.008
Unistellar/ SETI pipeline	9171.6125 ± 0.0015 ➔ +4.0 ± 2.2 minutes	233 ± 13	0.117 ± 0.015
TESS prediction	9171.6097 ± 0.0007	235.5 ± 2.0	0.1071 ± 0.0063



eVscope Specifications

Field of view 37' x 28'
Aperture 114 mm
Focal length 450 mm
Sony IMX224 Bayer CMOS sensor
400–950 nm; clear filter
Auto field detection

Data Reduction

Raw images (3.95 s each) were dark-subtracted, aligned, & averaged to integration times of 114.6 s and 86.9 s for Justus & Bruno's data, respectively. Using HOPS (left), Unistellar/SETI's Python pipeline (center), & EXOTIC software (not shown), fluxes were measured from images via differential aperture photometry. Relative fluxes were detrended & combined into a complete light curve, then fit with transit models via MCMC (HOPS), least-squares (Unistellar/SETI), and nested sampler (EXOTIC) methods to independently measure transit & planet properties.

CONCLUSIONS

We detected a transit by TESS exoplanet candidate TOI 2031.01 consistent with predicted parameters–notably, within ~6 minutes for the mid-transit time. Data were individually uploaded to the public AAVSO Exoplanet Database for future analyses: observer codes GBRC, RJUB, and UNIS: app.aavso.org/exosite.